SECTION 15512
HEATING HOT WATER BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. This Section includes two types of heating Hot Water boilers. Boilers shall be complete with all accessories and controls required for the efficient & safe operation of the system.
   1. Forced Draft, Gas fired, “Water-Tube” design
   2. Forced Draft, Gas fired, “Fire-Tube” design
   3. Positive pressure, double wall combustion vent stack

B. Related Sections include the following:
   1. Division 15, Section 15050, Piping Systems
   2. Division 15, Section 15055, Motors
   3. Division 15, Section 15100, Valves
   4. Division 15, Section 15106, CHW, CNDW, TW, HW, Condensate & PW Piping
   5. Division 15, Section 15108, Natural Gas Piping
   6. Division 15, Section 15185, Hydronic Pumps
   7. Division 15, Section 15189, Chemical Treatment
   8. Division 15, Section 15950, Direct Digital Control Systems
   9. Division 17, Instrumentation and Controls

1.3 REFERENCES

A. American Society of Mechanical Engineers (ASME)
   1. ASME (1998) Boiler and Pressure Vessel Code: Section I, “Heating Boiler”.
   2. ASME (1998) Boiler and Pressure Vessel Code: Section I, “Power Boiler”.

B. American Society for Testing and Materials (ASTM)
   1. ASTM A 126-93 Gray Iron Castings for Valves, Flanges, and pipe fittings
   2. ASTM B 62-93 Composition Bronze or Ounce metal castings

C. Factory Mutual (FM)

D. International Boiler Rating (I=B=R), The Hydronic Institute. (1989) Testing and Rating Standard for Heating Boilers

E. International Refrigerating Institute (IRI)

F. National Fire Protection Association (NFPA)
   1. NFPA 70 (1999) National Electrical Code
   2. NFPA 54 (1996) National Fuel Gas Code
   3. NFPA 211 (1966) Standards for Chimneys, Fire Places, Vents and Solid fuel burning appliances
   4. NFPA 8501 (1977) Single Burner Boiler operation

G. National electrical Manufacturers Association (NEMA)

1. NEMA 250-91 Enclosures for Electrical Equipment (1000 volts maximum)
2. NEMA MG1-93 Motors and Generators

H. Underwriters Laboratories Inc (UL)
1. UL 486 A-91 (1995) Wire Connectors and Soldering Lugs for use with copper Conductors
2. UL 486 B-91 (1995) Wire Connectors for use with Aluminum Conductors.

I. Occupational Safety hazards Association (OSHA)

J. Comply with DOE Standard 1020-94 seismic performance category PC-1.

1.4 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, and method of field assembly, components, seismic restraint, and location and size of each field connection.
1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Source Quality Control Tests and Inspection Reports: Indicate and interpret test results for compliance with performance requirements before shipping.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Operations and Maintenance Data: Include Operation and Maintenance (O&M) manuals as specified in General and Supplementary General Conditions. Operation and Maintenance guides shall include a complete parts list and wiring diagrams for each boiler.

1.5 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. ASME Compliance: Fabricate and label boilers to comply with the ASME Boiler and Pressure Vessel Code: Section IV, "Heating Boilers" and shall bear an ASME “H” stamp for maximum working pressure of 125 psig and 250°F temperature.

C. FM Compliance: Control devices and central sequences according to requirements of FM.

D. I=B=R Compliance: Boilers tested and rated according to the Hydronics Institute's "Testing and Rating Standard for Heating Boilers," with I=B=R emblem on a nameplate affixed to the boiler.

E. Comply with NFPA 70 for electrical components and installation.

F. Comply with DOE Standard 1020-94 seismic performance category PC-1.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3, Section 03300, and “Cast-in-Place Concrete."

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
   1. Warranty Period: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Factory packaged boilers size and capacity shall be as indicated in equipment schedules and as shown on drawings. Boiler package shall be complete and shall include the boiler shell, tubes tube sheets, insulation, casing, gas train, boiler trim, gas burner, burner flame failure control system, IFGR control system, air compressor, control panel and accessories.

2.2 PACKAGED UNITS

A. Description: Steel water-tube boiler with integral burner, burner controls, boiler trim, accessories, refractory, insulation, and jacket.
   1. Heat Exchanger: Flexible steel tubes wedged or welded into steel headers.
   2. Water-Pressure Rating: 125 psig (860 kPa).
   3. Mount boiler on heavy-steel base frame.
   4. Factory assembled with supply- and return-piping, fuel, blow-down, electrical, and vent connections.
   5. Lifting Lugs: 2, permanently attached to top of boiler.
   6. Access: Removable panels and access doors for inspection and for cleaning when doors are open.
   7. Observation Ports: At both ends of boiler for inspection of flame conditions.
   8. Exhaust-Gas Vent: On boiler top, complete with exhaust-gas thermometer.
   9. Insulation and Jacket: Minimum of 2-inch- (50-mm-) thick, glass fiber or mineral-wool-blanket insulation on boiler shell, covered with sheet-metal jacket.
   10. Painting: Factory-applied, enamel finish on boiler, base frame, and components' assembly.

B. Description: Modular, fire-tube boilers, factory assembled and wired to require only supply, return, fuel, blow-down, electrical, and vent connections.
   1. Heat Exchanger: multiple-pass, submerged exchanger with primary combustion chamber and tubular fire tubes with exhaust-vent connector.
   2. Vessel: Steel, fabricated according to the ASME Boiler and Pressure Vessel Code, Section IV, for 125-psig (860-kPa) operating pressure.
   3. Mount boiler on heavy-steel base frame, complete with integral forced-draft burner, burner controls, boiler trim, and refractory.
   4. Access: Manufacturer's standard number of hand holes or man ways.
   5. Insulation and Jacket: Minimum of 2-inch- (50-mm-) thick, glass fiber or mineral-wool-blanket insulation on boiler shell, covered with galvanized sheet-metal jacket.
   6. Painting: Factory-applied, enamel finish on boiler, base frame, and components' assembly.

2.3 HOT-WATER BOILER TRIM

A. Safety-Relief Valve: ASME rated, factory set 15 psi above operating pressure to protect boiler and piping.

B. Water Connections: Internal thermal circulation to mix return water with water in boiler.

C. Drain Valves: At low points.

D. Dip Tube: Integral part of the water outlet and air-vent tapping in boiler shell for removing entrained air.

E. Low-Water Cutoff: Mounted on side of boiler; factory wired into burner control circuit to prevent burner operation if boiler water falls below a safe level.

F. Operating Controls: Prewired, factory-assembled electric control including pilot safety and thermocouple transformer, 24-V gas valve, manual main and pilot valves, and junction box.

G. Pressure Gages: Mounted on boiler, 4 inches (100 mm) in diameter, with range to suit operating pressure.

H. Temperature Gages: Mounted on boiler, with temperature-sensing element located adjacent to water outlet.

I. Temperature Controls: Electronic temperature controller to maintain boiler water temperature with electronic sensor. Safety Controls: high-pressure limit control.

2.4 GAS BURNERS

A. Fuel: Natural gas.

B. Forced-Draft Burner Blower: Manufacturer's standard blower mounted on boiler front, directly connected to motor.

C. Gas Burner: High-radiant, multi-port-type burner, integral with front head of boiler, approved for operation with natural, manufactured, or mixed gas.
   1. Burner Operation and Combustion-Air Control: Full-modulation principle, 4-to-1 turndown ratios. Motor-operated combustion-air damper and cam-operated, butterfly gas-metering valve, operated by a single damper-control motor. Regulate fire according to load demand. Operate damper motor by potentiometer positioning controls. Return burner to low-fire position for ignition.
   2. Gas Pilot: Premix type with automatic electric ignition, with electronic detector to monitor pilot. Primary fuel valve cannot open until pilot flame has been established.

D. Gas-Piping Train: Integrally mounted, with lubricated plug cock located upstream from primary valve for manual shutoff, plugged leakage test cock, second lubricated plug cock, and the following plus comply with IRI gas train requirements:
   1. Primary gas shutoff valve, motor operated with spring return, starts and stops gas burner, and closes automatically in the event of power failure, flame failure, or low-water condition.
   2. Proof-of-closure switch on primary valve, and high- and low-gas-pressure switches.
   3. Second motorized, safety shutoff valve and additional plugged leakage test cock, with proof-of-closure switch and manual reset.
   4. Vent valve located between safety shutoff valves.

E. Emission Controls: Guarantee nitrous-oxide performance at 60 ppm, dry volume corrected to 3 percent oxygen.

F. Provide water flow switch in water return line to boiler. Similar to McDonnell & Miller FS7-4.

2.5 CONTROL SYSTEM REQUIREMENTS

A. Motor controllers, relays, and control switches factory assembled in NEMA 250, Type 1A enclosure, mounted on boiler front. Include the following options:
1. Indicating lights for low water level, flame failure, fuel-valve open, and load demand.
2. Programming relay controls ignition timing and starting and stopping boiler through pre-combustion and post-combustion purge.
3. Flame scanner shuts down boiler if ignition, pilot, or main flame fails.
4. Manual/automatic selector switch and damper motor-positioning switch to permit automatic firing according to load demand, or manual control of firing rate at any desired point between low fire and maximum rating.
5. Heat, and moisture-resistant wire.

B. The manufacture shall provide the following device control and monitoring signals (as required) to interface with PLCs or the conventional facilities control system.
1. Device input – linear set point signal form PLC (analog).
2. Device output – controlled variable feedback signal to PLC (analog).
3. Device input – start/stop command signals form PLC (digital).
4. Device output – fault/ alarm signal to PLC (digital).

These signals shall be 24V DC and/or 4-20 mA DC signals cabled to the nearest PLC I/O rack or a Control Net signal that can be read by Allen-Bradley ControlLogix PLCs with no software development. Dry contact closures shall be compatible with 24V DC control circuits. Analog signals shall be accurate within ± 1% of span. Digital and Analog loop power will be supplied fro the PLC cabinet by others. Signal conditioning shall be provided by the device (as required) such that analog input signals received from the PLC and analog output signals sent to the PLC will be a linear representation of the signal range (0-100%).

2.6 MOTORS

A. Refer to Division 15, Section 15055 "Motors" for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

C. Enclosure Type: Open dripproof motors where satisfactorily housed or remotely located during operation.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect boilers according to the ASME Boiler and Pressure Vessel Code, Section IV for low-pressure boilers.

2.8 POSITIVE PRESSURE DOUBLE-WALL COMBUSTION VENT STACK

A. Provide boiler stack gas vent system engineered and constructed to develop a positive flow adequate to exhaust all flue gases to outside atmosphere, without condensation within the vent. All flue carrying parts of vent system shall be double-wall gas vent type and shall be in full compliance with the terms of it's UL listing, and in accordance with the standards of NFPA 211 and stack manufacturer's recommendation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine area to receive boiler for compliance with requirements for installation tolerances and other conditions affecting boiler performance. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install boilers level and plumb, according to manufacturer's written instructions and referenced standards. Provide factory recommended seismic restraint supports to meet the requirements outlined in DOE Standard 1020-94.

B. Install gas-fired boilers according to NFPA 54.

C. Support boilers on 4-inch- (100-mm-) thick concrete base, 4 inches (100 mm) larger on each side than base of unit. Dowel base to floor on 18-inch (450-mm) centers along perimeter of base. Cast anchor-bolt inserts through base into floor.

D. Assemble boiler sections in sequence and seal between each section. Assemble boiler trim according to manufacturer's written installation instructions.

E. Install electrical devices furnished with boiler, but not specified to be factory mounted.

3.3 CONNECTIONS

A. Connect gas piping full size to boiler gas-train inlet with union.

B. Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.

C. Install piping from safety-relief valves to nearest floor drain. Provide flexible pipe connector between relief valve and pipe. Support pipe independent from connector and valve.

D. Connect breeching to boiler outlet, full size of outlet.

E. Electrical: Comply with applicable requirements in Division 16 Sections.

F. Ground equipment.
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to supervise the field assembly of components and installation of boilers, including piping and electrical connections. Report results in writing.
   1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Hydrostatically test assembled boiler and piping, according to applicable sections of the ASME Boiler and Pressure Vessel Code.

3.5 CLEANING

A. Flush and clean boilers on completion of installation, according to manufacturer's written instructions.

B. After completing boiler installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes including chips, scratches, and abrasions with manufacturer's touchup paint.

3.6 COMMISSIONING

A. Engage a factory-authorized service representative to provide startup service.

B. Verify that installation is as indicated and specified.
   1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections. Do not proceed with boiler startup until wiring installation is acceptable to equipment Installer.

C. Complete manufacturer's installation and startup checklist and verify the following:
   1. Boiler is level on concrete base.
   2. Flue and chimney are installed without visible damage.
   3. No damage is visible to boiler jacket, refractory, or combustion chamber.
   4. Pressure-reducing valves are checked for correct operation and specified relief pressure. Adjust as required.
   5. Clearances have been provided and piping is flanged for easy removal and servicing.
   6. Heating circuit pipes have been connected to correct ports.
   7. Labels are clearly visible.
   8. Boiler, burner, and flue are clean and free of construction debris.
   9. Burner blower rotates in correct direction.
   10. Pressure and temperature gages are installed.
   11. Control installations are completed.

D. Ensure pumps operate properly.

E. Check operation of pressure-reducing valve on gas train, including venting.

F. Check that fluid-level, flow-switch, and high-temperature interlocks are in place.

G. Start pumps and boilers, and adjust burners for maximum operating efficiency.
   1. Fill out startup checklist and attach copy with Contractor Startup Report.
   2. Check and record performance of factory-provided boiler protection devices and firing sequences.
   3. Check and record performance of boiler fluid-level, flow-switch, and high-temperature interlocks.
   4. Run-in boilers as recommended or required by manufacturer.

H. Perform the following tests for each firing rate for high/low burners and for 100, 66, and 33 percent load for modulating burners. Adjust boiler combustion efficiency at each firing rate. Measure and record the following:
   1. Gas pressure on manifold.
   2. Combustion-air temperature at inlet to burner.
   3. Flue-gas temperature at boiler discharge.
   4. Flue-gas carbon dioxide and oxygen concentration.
   5. Natural flue draft.

I. Measure and record water flow rate, pressure drops, and temperature rise through each boiler.

J. Inspect expansion tank, makeup water meter, tank pressure, pressure-reducing valve, water level, and backflow-preventer.

3.7 DEMONSTRATION

A. Engage the services of a factory-authorized service representative to train operating and maintenance personnel as identified by the Construction Manager (CM) on procedures and schedules related to operations such as: start-up, and shutdown, troubleshooting, servicing and preventative maintenance.
   1. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.
   2. Review data in the Operation and Maintenance (O&M) manuals during training periods.
   3. Refer to closeout requirements in general and Supplementary General Conditions.
   4. Schedule training with Construction Manager (CM) with at least 7 days' advance notice.

END OF SECTION 15512